TWO-DIMENSIONAL CMOS SENSOR ARRAY TO IMAGE DOCUMENTS AND OTHER FLAT OBJECTS

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DESCRIPTION OF RELATED ART

[0001] When using a conventional flatbed scanner, the document is placed on the glass platen and the cover is closed. A light source (e.g., cold cathode fluorescent lamp, a xenon lamp, or light emitting diodes) is used to illuminate the document. A scan head (e.g., consisting of mirrors, lens, filter, and image sensor array) is moved slowly down the document (e.g., by a belt that is attached to a stepper motor or a gear set linked to a DC motor). The scan head is attached to a stabilizer bar to ensure that there is no wobble or deviation in the pass (i.e., a single complete scan of the document).

[0002] The image of the document is reflected by angled mirrors to form a folded light path. The last mirror reflects the image onto a lens. The lens focuses the image on an image sensor. A typical charged coupled device (CCD) image sensor has 3 linear CCD sensor arrays. Each linear array has a different color filter (e.g., red, green, and blue) placed directly on top of the CCD sensors. The scanner then combines the data from the linear CCD sensor arrays into a single full-color image. In comparison, a typical contact image sensor (CIS) has one linear complementary metal oxide semiconductor (CMOS) sensor array that captures an image sequentially illuminated by red, green, and blue light sources (e.g., light emitting diodes). The scanner then combines the data from the linear CMOS sensor array into a single full-color image.

[0003] Scanners vary in resolution and sharpness. Most flatbed scanners have a true hardware resolution of at least 600×600 dots per inch (dpi). The scanner's dpi is determined by the number of sensors in a single row (x-direction sampling rate) of the sensor array and by the precision of the stepper motor (y-direction sampling rate). For example, if the resolution is 600×600 dpi and the scanner is capable of scanning a letter-sized document,

then the CCD image sensor would have three linear arrays each having 5,100 sensors while a CIS would have one linear array of 5,100 sensors. The stepper motor in this example is able to move in increments equal to 1/600ths of an inch.

SUMMARY

[0004] In one embodiment of the invention, a scanner includes a housing, a transparent platen atop the housing for receiving an object to be scanned, and a carriage operable to travel along a horizontal direction and a vertical direction. The carriage includes a light source for illuminating the object and a rectangular photodetector array for simultaneously detecting light intensity of multiple scan lines.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Fig. 1 illustrates a top view of a flatbed scanner in one embodiment of the invention.

[0006] Figs. 2 and 3 illustrate cross-sectional side views of the flatbed scanner of Fig. 1 in one embodiment of the invention.

[0007] Figs. 4 and 5 illustrate movement of a rectangular photodetector array in embodiments of the invention.

[0008] Fig. 6 illustrates a cross-sectional side view of a sheet feeder scanner in one embodiment of the invention.

[0009] Fig. 7 illustrates a cross-sectional side view of a flatbed scanner in one embodiment of the invention.

[0010] Use of the same reference numbers in different figures indicates similar or identical elements.

DETAILED DESCRIPTION

[0011] Fig. 1 illustrates a flatbed scanner 10 in one embodiment of the invention. Scanner 10 includes a housing 12, a cover 14 hingedly attached to housing 12, a transparent (e.g., glass) platen 16 atop housing 12, and a carriage 18 within housing 12. Carriage 18 travels within housing 12 on a vertical gear channel 20 and a horizontal gear channel 22. Carriage 18 includes a rectangular photodetector array 24 and an illumination ring 26.

[0012] In one embodiment, photodetector array 24 has multiple (e.g., more than three) rows of complementary metal oxide semiconductor (CMOS) sensors. In one embodiment, photodetector array 24 consists of a variety of red, blue, and green photodiodes and the actual color at the site of each photodiode is interpolated from the colors of the neighboring photodiodes. In a lower-end scanner with a slower throughput, photodetector array 24 may have a resolution of 352×288 pixels. In a higher-end scanner with a faster throughput, photodetector array 24 may have 1.3 megapixel of resolution to enable the entire page to be scanned more quickly. In one embodiment, illumination ring 26 are light emitting diodes (LEDs) formed around photodetector array 24 on the same die.

[0013] Fig. 2 illustrates a cross-section view of carriage 18 along line A (Fig. 1) in one embodiment of the invention. Photodetector array 24 and illumination ring 26 are mounted on a plate 32. Mounting plate 32 includes a horizontal guide 34. A motor 36 and associated gear system 38 are mounted to plate 32. A horizontal carriage bar 40 defines a horizontal guide channel 42 that receives guide 34. Horizontal carriage bar 40 further defines gear channel 22 that receives a gear from gear system 38. Gear channel 22 includes teeth that engage gear system 38. In operation, motor 36 drives gear system 38 to move carriage 18 horizontally across the object to be scanned. A flex cable 50 (Fig. 3) moves the image data from photodetector array 24 to horizontal carriage bar 40.

[0014] Fig. 3 illustrates a cross-section view of carriage 18 along line B (Fig. 1) in one embodiment of the invention. Horizontal carriage bar 40 includes vertical guides 44A and 44B. A motor 46 and associated gear system 48 are mounted to horizontal carriage bar 40. Housing 12 defines vertical guide channels 52A and 52B that receive corresponding guides 44A and 44B. Housing 12 further defines gear channel 20 that receives a gear from gear system 48. Gear channel 48 includes teeth that engage gear system 48. In operation, motor 46 drives gear system 48 to move carriage 18 vertically down the object to be scanned. A flex cable 52 moves the image data from horizontal carriage bar 40 to the scanner base for the data to be processed by the scanner electronics.

[0015] During scanning, the object to be scanned is placed on glass platen 16. Illumination ring 26 then illuminates a portion of the object. Light is reflected from this portion of the object and simultaneously captured as multiple (e.g., more than three) scan lines by rectangular photodetector array 24. Photodetector array 24 converts the light intensity of this portion into electrical signals. Fig. 4 illustrates that, instead of slowly moving scan line by

scan line as in conventional flatbed scanners, carriage 18 moves horizontally or vertically in large increments (e.g., exemplified by a movement 62 of sensor 64) equal to or greater than the corresponding width and height of photodetector array 24 in one embodiment of the invention. This allows for a faster scanning process. After the entire object is scanned, software is used to interpolate pixel colors and to stitch together the scanned portions into a single color image of the object. Software can also be used to correct any non-uniform lighting.

[0016] Fig. 5 illustrates that the resolution can be increased by micro-stepping rectangular photodetector array 24 both horizontally and vertically in small increments (e.g., exemplified by a movement 66 of sensor 64) in one embodiment of the invention. The horizontal increment is less than the horizontal spacing between adjacent sensors while the vertical increment is less than the vertical spacing between adjacent sensors. For example, if photodetector array 24 produces 300×300 dpi, then the resolution can be doubled to 600×600 dpi by (1) capturing an image of the object, (2) moving photodetector array 24 by half (½) a dpi in the horizontal and the vertical directions, and (3) capturing another image of the object. Software is then used to combine the two images to form a 600×600 dpi image of the object. After a micro-step, carriage 18 can move horizontally or vertically in a large increment to scan the next area on the object, followed by another micro-step.

[0017] Fig. 6 illustrates a side cross-sectional view of a sheet feeder scanner 100 in one embodiment of the invention. Scanner 100 includes a housing 102, a sheet feeder 104, feed rollers 106, and a carriage 108 within housing 102. Sheet feeder 104 grabs a single sheet 110 of document from a stack 112 and moves it vertically to feed rollers 106. Feed rollers 106 move sheet 110 past carriage 108. Carriage 108 includes rectangular photodetector array 24 and illumination ring 26. To scan sheet 110, carriage 108 travels horizontally within housing 102 on horizontal gear channel 22 and horizontal guide channel 42. Carriage 108 is similar to carriage 18 but without the vertical travel components because feed rollers 106 function to move the paper vertically past carriage 108. Instead of moving the paper slowly scan line by scan line as in conventional sheet feeder scanners, feed rollers 106 vertically move single sheet 110 in large increments equal to or greater than the height of photodetector array 24. Again, this allows for a faster scanning process because portions of the documents are simultaneously captured as multiple scan lines by rectangular photodetector array 24.

[0018] Fig. 7 illustrates a side cross-sectional view of a flatbed scanner 200 in one

embodiment of the invention. Scanner 200 includes a housing 212, a glass platen 216 atop housing 212, a stationary rectangular photodetector array 218 with optics 220, and light sources 222.

[0019] During scanning, the object to be scanned (e.g., object 224) is placed on glass platen 16. Light sources 222 then illuminates the entire object by directing light onto object 224 or bouncing light off the sidewalls of housing 212 and then onto object 224. Light is reflected from object 224 and directed by optics 220 onto rectangular photodetector array 218. Photodetector array 218 converts the light intensity of the scanned object into electrical signals. Instead of moving a carriage as in conventional scanners, photodetector array 218 remains stationary and scans the entire object at once. Again, this allows for a faster scanning process because multiple scan lines are captured simultaneously by photodetector array 218. Software can be used to interpolate pixel colors and to correct any non-uniform lighting.

[0020] Various other adaptations and combinations of features of the embodiments disclosed are within the scope of the invention. Numerous embodiments are encompassed by the following claims.